

APPLICATION
for
UNITED STATES PATENT

To Whom It May Concern:

BE IT KNOWN THAT We, Tetsuya WATANABE, a citizen of Japan, residing at c/o Tsu Plant of Teijin Seiki Co., Ltd., 594, Aza Icchoda, Katada-cho, Tsu-shi, Mie, Japan, Hiroki MORI, a citizen of Japan, residing at c/o Tsu Plant of Teijin Seiki Co., Ltd., 594, Aza Icchoda, Katada-cho, Tsu-shi, Mie, Japan and Chohei OKUNO, a citizen of Japan, residing at c/o Tsu Plant of Teijin Seiki Co., Ltd., 594, Aza Icchoda, Katada-cho, Tsu-shi, Mie, Japan, have made a new and useful improvement in "Shaft Sealing Apparatus" of which the following is the true and exact specification, reference being had to the accompanying drawings.

SHAFT SEALING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 The present invention relates to a shaft sealing apparatus, and more particularly to a shaft sealing apparatus for sealing the gaps between a driving shaft and other parts around the driving shaft to have the driving shaft movably extending in a vacuum chamber and operatively connected with a handling mechanism disposed in the vacuum chamber.

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2. Description of the Related Art

 Up until now, there have been proposed a wide variety of conventional shaft sealing apparatuses each designed to seal the gaps between a driving shaft and other parts around the driving shaft to have the driving shaft movably extending in a vacuum chamber and operatively connected with a handling mechanism disposed in the vacuum chamber.

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 The conventional shaft sealing apparatuses thus proposed have so far been available for various vacuum processing apparatuses such as a semiconductor producing apparatus. In general, the vacuum processing apparatus of this kind is equipped with a vacuum casing formed with a vacuum chamber and a handling mechanism such as a manipulator designed to handle wafers and other substrates in the vacuum chamber. The vacuum processing apparatus thus constructed is operative to produce various precision products including an integrated circuit (IC), a large scale integrated circuit (LSI) and a liquid crystal display (LCD) base plate.

20 The precision products produced by the vacuum processing apparatus are used for a semiconductor device, a liquid crystal display (LCD) and other objects.

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 In recent years, the precision products described in the above are produced in the vacuum chamber maintained at a constant vacuum level, for example, a high vacuum level (1×10^{-1} to 1×10^{-5} Pa) and an ultra high vacuum level (less than 1×10^{-5} Pa), resulting from the fact that the process of producing the precision products has been progressed to obtain more excellent quality and to reduce inferior products. The conventional shaft sealing apparatus is, therefore, installed in the vacuum processing apparatus to have the vacuum chamber maintained at a constant vacuum level.

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35 The conventional shaft sealing apparatus of this type comprises a vacuum casing formed with a vacuum chamber and an opening to have the vacuum chamber held in communication with the atmosphere through the opening, a shaft housing

fixedly connected with the vacuum casing, and a driving shaft received in the shaft housing to be rotatably supported by the shaft housing. The driving shaft has a first axial end extending in the vacuum chamber to be operatively connected with the handling mechanism disposed in the vacuum chamber, and a second axial end
5 extending in the atmosphere to be operatively connected with an electric motor. The handling mechanism includes a handling member pivotally supported by the driving shaft to be operative to handle wafers and other substrates in the vacuum chamber.

The conventional shaft sealing apparatus further comprises a plurality of magnetic fluid seals intervening between the driving shaft and the shaft housing to
10 hermetically seal the gap between the driving shaft and the shaft housing. The magnetic fluid seals are axially disposed in series between the driving shaft and the shaft housing, resulting from the fact that each of the magnetic fluid seals has a resistance pressure of approximately 20 kPa.

The conventional shaft sealing apparatus thus constructed, however,
15 encounters such a problem that the conventional shaft sealing apparatus is complicated in construction and thus increased in size, resulting from the fact that the conventional shaft sealing apparatus is required to comprise a number of magnetic fluid seals axially disposed in series between the driving shaft and the shaft housing.

The conventional shaft sealing apparatus described in the above encounters
20 another problem that the conventional shaft sealing apparatus is difficult to assemble, resulting from the fact that the conventional shaft sealing apparatus is complicated in construction and thus large in size.

The conventional shaft sealing apparatus described in the above encounters
25 further problem that the driving shaft cannot be axially movably supported by the shaft housing, resulting from the fact that the magnetic fluid seals intervene between the driving shaft and the shaft housing.

While it has been described in the above that the conventional shaft sealing
apparatus comprises a driving shaft movably extending in the vacuum chamber, the driving shaft may be replaced by a driving shaft accommodated in a vacuum chamber
30 in order to have the vacuum chamber maintained at a constant vacuum level. This type of shaft sealing apparatus is disclosed in Japanese Patent Publication No. 2761438.

The conventional shaft sealing apparatus of this type comprises a vacuum casing formed with a casing chamber and an opening, a shaft housing formed with a
35 housing chamber and axially movably connected with the vacuum casing through a bellows unit, and a driving shaft received in the shaft housing to be rotatably supported by the shaft housing. The casing chamber is held in communication with